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November 22*d*.

Mr. Ord, President, in the Chair.

Letters were read—

From the Historical Society of Pennsylvania, dated Nov. 15, 1853; from the Royal Geographical Institute of Vienna, dated August 21, 1853; and from the Royal Academy of Sciences of Stockholm, dated July 7, 1853, severally acknowledging the receipt of the Proceedings.

From the Royal Geological Institute of Vienna, dated August 21, 1853; from the Imperial Academy of Sciences of Vienna, dated August 24, 1853, and from Dr. M. Boué, addressed to Mr. Isaac Lea, severally accompanying donations to the Library announced this evening.

Dr. S. Weir Mitchell read a paper entitled "On the effect of some states of Respiration upon the Pulse;" which was referred to Dr. Leidy, Dr. Hallowell and Dr. Ruschenberger.

Mr. Lea remarked that, when recently in Paris, he had found the original specimen of *Mulleria*, described by Ferussac in 1823, and again described by D'Orbigny as *Acostæa*, which identity Mr. Lea had pointed out in a paper read before the Academy in 1851, and published in Part 2, Vol. 2, New Series of the Journal. The specimen alluded to possessed the appended bivalve shell which belonged to D'Orbigny's specimen.

Mr. Lea also stated that the Reptiles referred to by Dr. Mantell, as occurring in the Old Red Sandstone of the North of Scotland, were now believed to be of a much later date.

November 29th.

Vice-President Bridges in the Chair.

The Committee on Mr. Girard's paper—"Researches upon Nemerteaus and Planarians"—reported in favor of publication in the Journal.

The Committee on the following paper by Dr. Mitchell, reported in favor of publication.

On the influence of some states of Respiration upon the Pulse.

By S. Weir Mitchell, M. D.

I desire to offer to the Academy an abstract of a paper upon the influence of some states of respiration on the pulse. As the original paper will shortly appear at length in the American Journal of Medical Science, I shall be as brief as possible.

Laborious respiration may be studied under four heads.

1. The movement of inspiration, thorax in motion.
2. Complete and full inspiration, thorax at rest.
3. The movement of expiration, thorax moving.
4. Complete expiration, thorax at rest.

The dynamical relations of the blood to the heart and lungs will vary in each of these cases.

During inspiratory movement the lung is expanded, and, while air passes into its cells, the blood of the greater vessels and of the two hearts tends to enter its sponge-like tissue, under the influence of atmospheric pressure. A reverse process occurs in expiration, and some blood, as well as most of the air is driven out of the lung.

During prolonged inspiration, therefore, the left heart receives but little blood. In the state of expiration, on the contrary, it receives a larger share. But the heart's movements are to some extent regulated by the amount of blood which enters its cavities, and hence we have in inspiratory movements a slow pulse, and in expiratory action a quick pulse. Such are, to a certain extent, the explanations of Dr. J. Reid, who noticed the phenomena in question, during his vivisections. I have found no occasion to contradict his conclusions, and my own explanations go to prove what that great physiologist merely inferred. I have also made certain novel applications of this knowledge, such as will be found in my paper, detailed at some length.

I have observed the above mentioned phenomena on animals, and even in the unusually prolonged respiratory movements of a few human subjects.

During fixed inspiration the pulse lowers, in a large proportion of men. In fixed expiration, on the contrary, the pulse rises. Thus, an average of 40 cases gave the following results :—

Normal pulse 80, inspiratory pulse 70, difference 10 ; expiratory pulse 93 ; excess over normal pulse, 13 beats ; extreme of numeral difference between the induced pulses, 23.

Of the 40 pulses thus recorded, during fixed inspiration, 6 fell, over 20 beats, 8 fell, over 12 and 18, 5 or over 5 beats, per minute.

Some of the most extreme cases are yet more remarkable. Thus pulses of 108, 96 and 92, fell respectively, 49, 28 and 26, per minute. The largest rise in fixed expiration was 36 pulsations per minute ; the normal pulse being 83. In a case of hypertrophy of the heart, with a pulse of 80, it fell so much in fixed inspiration and rose so much in a like expiratory condition, as to make a total difference of fifty pulsations between the two states.

For more minute information, I refer to the paper above mentioned.

I offer the following explanation of the facts thus recorded.

It is possible that nerve power may in some way assist in producing the results : of this, I have no direct evidence. In asphyxia, the heart beats rapidly at first, becoming slow, as the circulation is checked in the capillaries of the lungs. In this stage of asphyxia, the right heart is congested and the left heart has too little blood. That slow pulsation of the heart which then ensues has usually been ascribed by physiologists, in part at least, to this double irregularity in the distribution of the blood.

During profound and retained inspiration, we dilate the air cells at the expense of the neighboring capillaries. As a consequence their circulation is somewhat impeded, blood accumulates in the right heart, is deficient in the left heart, and the whole organ beats slowly. Dilation of the pulmonary vesicles may be produced by direct distension, as when we blow into the trachea, or by forces acting from without, as occurs during life, in the thoracic movements. In the first case, we have the additional element of pressure, which, however, does not very materially alter the conditions, as I have shown elsewhere. The following experiments illustrate the propositions above stated.

Owing to difficulties almost insurmountable, the dilatation of the air cells was made by insufflation, and not by expansible forces acting from without. A tube was placed in the trachea of a pair of dead lungs taken from a sheep, a glass tube ½ inch in diameter and three feet long, was tied in the mouth of the pulmonary artery. A similar tube was in like manner adjusted to the left auricle, so as to receive all fluids coming from the lungs. A column of fluid was placed in the tube of the pulmonary artery. It ran into the lungs, and at last rose slowly in the tube which I had tied in the mouth of the left auricle. The lung was now filled with air by gently inflating through the tracheal tube. As the lung expanded, the fluid usually fell a little in both tubes, and most in that of the pulmonary artery. The water still passed through the vessels until a state of extreme tension was attained, when the tide was checked. To do this completely, required a fuller inflation than could occur in health. In fact, I have sometimes been able to force both columns of liquid in a reverse direction, 2 or 3 inches up the tubes. As the lung was allowed to contract in expiration, the fluid ran through the vessels with a facility which seemed greatest during complete expiration. When the bloody fluid stood at a level in both tubes, inspiratory movement lowered it in both tubes. Expiratory movement caused it to rise in both.

During numerous vivisections, I noted the following corroborative facts :—

The lung grows pallid in extreme inspiration, it flushes to a deep red in expiration. That this change of color is not due to a mere aggregation of the capillaries, is clear from the following fact. During complete inspiration the lung was scratched so as to open some capillary vessels. No bleeding occurred until the lung was allowed to contract, when the wound began to ooze. The flow of blood was greatest in complete expiration. Care must be taken not to wound any large vessel. The illustrative bearing of these facts upon my preceding remarks is too plain for further comment.

At the moment of complete inspiration, the capillary circulation is retarded or checked. As a consequence there is an accumulation of blood in the pulmonary artery and right heart, and a deficiency of blood in the pulmonary vein and left heart.

Owing to this double disturbance, the heart beats slowly. The same set of causes, produced in another way, lessen the heart beats in one of the stages of asphyxia. This view is also supported in other ways, and by certain facts too numerous for mention here.

In expiratory fixation the heart quickens as I have very amply proved.

This is due to several causes :—

1. In expiration, however complete, the lung still contains enough of air to keep its vesicles moderately open. Therefore the blood traverses its tissue with ease, until asphyxia ensues.

2. The muscular exertion requisite for a complete expiration is one-third greater than that which a full inspiration demands, and as we well know muscular exertion quickens the pulse.

3. Owing to this excess of expiratory force, and to the firm pressure exerted by the condensed lungs upon the heart, that organ is mechanically stimulated. If the heart of an animal be grasped during life it will flutter under the hand with a quick beat, and as if shuddering beneath the compressing agency. If the lung itself is firmly and equally pressed against the heart the same result occurs.

To the combined influence of the three causes above enumerated, I ascribe the rapid pulse of fixed expiration. I have therefore shown that in the movements of respiration, as well as in states of extreme inspiratory and expiratory fixation, the pulmonary circulation is subjected to singular and interesting modifications. I shall close my remarks with a single application.

During inspiration the lungs contain a maximum amount of blood which is to some degree retarded in the capillaries at the moment of inspiratory fulness. It is precisely at this moment that the lungs contain most oxygen. On the other hand, during expiration, and during expiratory fixation, the ærated blood, leaves the lung with the utmost facility. A regulation so beautiful as this should not be allowed to escape attention. For other and equally curious deductions I refer to the essay itself.

The Report of the Corresponding Secretary was read and adopted.

ELECTION.

The Rev. Joseph H. Wythes was elected a *Member* of the Academy.

December 6th.

Vice-President **Bridges** in the Chair.

Letters were read—

From the Zoological and Botanical Society of Vienna, dated 21st Aug., 1853, transmitting vols. 1 and 2 of their Transactions.

From the Royal Bavarian Academy of Sciences, dated Nov. 6, 1853,